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Vincent's rocks, Clifton, immediately below the Cliff, against which the suspension bridge over the Avon is designed to abut. The temperatures of the springs were 72° and 66° respectively; and the gas consisted of 92 parts of nitrogen, eight of oxygen, and three of carbonic acid. The author deduces from these facts arguments in confirmation of the views he has stated in the paper to which this is an appendix.

Mr. Faraday's Sixth Series of Experimental Researches in Electricity were resumed and concluded; and the reading of the Seventh Series commenced.

The Society then adjourned over the following Thursday, being the Day of the Martyrdom of King Charles the First, to meet again on the 6th of February.

February 6, 1834.

JOHN WILLIAM LUBBOCK, Esq., M.A., V.P. and Treasurer,
in the Chair.

Captain Chesney, Roy. Art.; Thomas Copeland, Esq.; the Right Hon. Sir Edward Cust, K.C.B.; James Horne, Esq.; John Russell Reeves, Esq.; Lieut.-Col. William Henry Sykes, E.I.C.S.; and John Waterhouse, Esq., were elected Fellows of the Society.

The reading of Mr. Faraday's Seventh Series of Experimental Researches in Electricity was resumed in continuation.

February 13, 1833.

HIS ROYAL HIGHNESS THE DUKE OF SUSSEX, K.G.,
President, in the Chair.

The reading of Mr. Faraday's papers was resumed and concluded.

"Experimental Researches in Electricity.—Sixth and Seventh Series." By Michael Faraday, Esq., D.C.L., F.R.S., Fullerian Professor of Chemistry in the Royal Institution of Great Britain.

In the course of his experimental investigation of a general and important law of electro-chemical action, which required the accurate measurement of the gases evolved during the decomposition of water and other substances, the author was led to the detection of a curious effect, which had never been previously noticed, and of which the knowledge, had he before possessed it, would have prevented many of the errors and inconsistencies occurring in the conclusions he at first deduced from his earlier experiments. The phenomenon observed was the gradual recombination of elements which had been previously separated from each other by voltaic action. This happened when, after water had been decomposed by voltaic electricity, the mixed gases resulting from such decomposition were left in con-

tact with the platina wires or plates, which had acted as poles ; for under these circumstances they gradually diminished in volume, water was reproduced, and at last the whole of the gases disappeared. On inquiring into the cause of this reunion of the elements of water, the author found that it was occasioned principally by the action of the piece of platina, which had served for the positive pole ; and also that the same piece of platina would produce a similar effect on a mixture of oxygen and hydrogen gases obtained by other and more ordinary kinds of chemical action. By closer examination, it was ascertained that the platina, which had been the negative pole, could produce the same effect. Finally, it was found that the only condition requisite for rendering the pieces of platina effective in this recombination of oxygen and hydrogen is their being perfectly clean, and that ordinary mechanical processes of cleaning are quite sufficient for bringing them into that condition, without the use of the battery. Plates of platina, cleaned by means of a cork, with a little emery and water, or dilute sulphuric acid, were rendered very active ; but they acquired the greatest power when first heated in a strong solution of caustic alkali, then dipped in water to wash off the alkali, next dipped in hot strong oil of vitriol, and finally left for ten or fifteen minutes in distilled water. Plates thus prepared, placed in tubes containing mixtures of oxygen and hydrogen gases, determined the gradual combination of their elements : the effect was at first slow, but became by degrees more rapid ; and heat was evolved to such a degree, indeed, as frequently to give rise to ignition and explosion.

The author regards this phenomenon as of the same kind as that discovered by Davy in the glowing platina ; that observed by Döbereiner in spongy platina, acting on a jet of hydrogen gas in atmospheric air ; and those so well experimented on by MM. Dulong and Thenard. In discussing the theory of these remarkable effects, the author advances some new views of the conditions of elasticity at the exterior of a mass of gaseous matter confined by solid surfaces. The elasticity of gases he considers as being dependent on the mutual action of the particles, especially of those which are contiguous to each other ; but this reciprocity of condition is wanting on the sides of the exterior particles which are next to the solid substance. Then, reasoning on the principle established by Dalton, that the particles of different gases are indifferent to one another, so that those of one gas may come within almost any distance of those of another gas, whatever may be the respective degrees of tension in each gas among the particles of its own kind, he concludes that the particles of a gas, or of a mixture of gases, which are next to the platina, or other solid body not of their own chemical nature, touch that surface by a contact as close as that by which the particles of a solid or liquid body touch each other. This proximity, together with the absence of any mutual relation of the gaseous particles to particles of their own kind, combined also with the direct attractive force exerted by the platina, or other solid body, on the particles of the gases, is sufficient, in the opinion of the author, to supply what is wanting in order to render effective the affinity between the particles of oxygen and hydrogen ; being, in

fact, equivalent to an increase of temperature, to solution, or to any of the other circumstances which are known to be capable of adding to the force of the affinities inherent in the substances themselves.

Some very curious cases of interference with this action of platina and other metals are next described. Thus, small quantities of carbonic oxide, or olefiant gas, mixed with the oxygen and hydrogen gases, totally prevent the effect in question; while very large quantities of carbonic acid, or nitrous oxide gas, do not prevent it: and it is remarkable, that the former of these gases do not affect the metallic plates permanently; for if the plates be removed from those mixtures, and put into pure oxygen and hydrogen gases, the combination of these elements takes place.

The author concludes by some general notice of numerous cases of physical action, which show the influence of certain modifications of the conditions of elasticity at the external surface of gaseous bodies.

The seventh series, which is a continuation of the subject of the fifth, namely, electro-chemical decomposition, commences with a preliminary exposition of the reasons which have induced the author to introduce into this department of science several new terms, which appear to be required in order to avoid errors and inaccuracies in the statement both of facts and theories. As a substitute for the term *pole*, and with a view to express also a part of the voltaic apparatus to which that name has never been applied, although it be identical with a pole in its relation to the current, the author proposes to employ the term *electrode*. The surfaces of the decomposing body, at which the positive current of electricity enters and passes out, are denominated respectively the *eisode* and the *exode*. Bodies which are decomposable by the electric current are called *electrolytes*, and when *electro-chemically decomposed*, they are said to be *electrolyzed*; the substances themselves, which are evolved in such cases, being called *zetodes*, and the terms *zeteisode* and *zetexode* being applied, accordingly as the substance passes in one direction or the other. The propriety and the advantage of employing these new terms, the author observes, can be properly appreciated only by an experience of their uses and applications in the exposition of the theory of decomposition given in the fifth series of these inquiries, and of that of definite electro-chemical action advanced and supported in the present paper.

The first section of this paper is occupied with the consideration of some general conditions of electro-chemical decomposition. It has been remarked, that the elements which are strongly opposed to each other in their chemical affinities are those most readily separated by the voltaic pile; and the discovery of the law of conduction, explained in the fourth series, has led to a great augmentation of the number of instances which are in conformity with this general observation: but it is here shown, that the proportion in which the elements of a body combine has great influence on the electro-chemical character of the resulting substance; and that numerous instances occur where, although one particular compound of two substances is decomposable, another is not. It appears, that whenever binary compounds of simple

bodies are thus related to one another, it is the proto-compounds, or those containing single proportions, which are decomposable, and that the per-compounds are not so.

The second section contains an account of a new instrument devised by the author, for exactly measuring electric currents, and which he terms the *volta-electrometer*. The current to be measured is made to pass through water acidulated by sulphuric acid, and the gases evolved by its decomposition are collected and measured, thereby giving at once an expression of the quantity of electricity which has passed. The principle on which this conclusion is founded is the new law discovered by the author, "*that the decomposing action of any current of electricity is constant for a constant quantity of electricity.*" The accuracy of this law was put to the test in every possible way, with regard to the decomposition of water, by making the same current pass in succession through two or more portions of water, under very different circumstances: but whatever were the variations made, whether by altering the size of the poles or electrodes, by increasing or lessening the intensity of the current or the strength of the solution, by varying its temperature or the mutual distance between the poles, or by introducing any other change in the circumstances of the experiment, still the effect was found to be the same; and a given quantity of electricity, whether passed in one or in many portions, invariably decomposed the same quantity of water. No doubt, therefore, remains as to the truth of the principle on which the volta-electrometer acts: but with regard to the practical application of the principle, several forms of the instrument are described by the author, and the mode of employing them, either as the measurers of absolute quantities, or as standards of comparison, are fully pointed out.

In the third section of the paper, the primary or secondary character of the bodies evolved at the electrodes is discussed. It is shown that they are secondary in a far greater number of cases than has usually been imagined; and that laws have been deduced with regard to the ultimate places of substances, from the appearance of the secondary products; so that certain conclusions, true in themselves, have hitherto been obtained by erroneous reasoning, since the facts which were supposed to support them have, in truth, no direct relation with those conclusions. The methods of distinguishing primary and secondary results from each other are explained, and the importance of this distinction towards the establishment of the law of definite electro-chemical action is insisted upon by the author.

The fourth section is entitled, "*On the definite Nature and Extent of Electro chemical Decomposition,*" and is considered by the author as by far the most important of this or indeed of the whole series of investigations of which he has now presented the results to the Royal Society. He adverts to the previous occasions on which he has already announced, more or less distinctly, this law of chemical action; and also to the instrument just explained as one of the examples of the principle about to be developed. He next refers to experiments described in another part, in which primary and secondary results are distinguished as establishing the same principle with regard to muriatic

acid ; the results showing, that not only the quantity of that acid decomposed is constant for a constant quantity of electricity, but that, when it is compared with water, by making one current of electricity pass through both substances, the quantities of each that are decomposed are very exactly the respective chemical equivalents of those bodies. The same current, for example, which can decompose nine parts by weight of water, can decompose thirty-seven parts by weight of muriatic acid, these numbers being respectively the chemical equivalents of those substances, as deduced from the phenomena of ordinary chemical action.

Cases of decomposition are then produced, in which bodies rendered fluid by heat, as oxides, chlorides, iodides, &c., are decomposed by the electric current, but still in conformity with the law of constancy of chemical action. Thus the current which could decompose an equivalent of water, could also decompose equivalents of muriatic acid, of proto-chloride of tin, of iodide of lead, of oxide of lead, and of many other bodies, notwithstanding the greatest differences in their temperature, in the size of the poles, and in other circumstances ; and even changes in the chemical nature of the poles or electrodes, and in their affinities for the evolved bodies, occasioned no change in the quantity of the body decomposed.

The author proceeds, in the last place, to consider a very important question with relation to chemical affinity, and the whole theory of electro-chemical action, namely, the absolute quantity of electricity associated with the particles or atoms of matter. This quantity he considers as precisely the same with that which is required to separate them from their combination with other particles when subjected to electrolytic action, and he brings many experiments to bear upon this point ; describing one, in particular, in which the chemical action of 32·5 parts of zinc, arranged as a voltaic battery, was able to evolve a current of electricity capable of decomposing and transferring the elements of 9 grains of water, being the full equivalent of that number. The relation of electricity, thus evolved, to that of the common electric machine is pointed out in a general way, and the enormous superiority as to quantity, in the former mode of action, is insisted upon. In conclusion, the author refers to a statement which he has made in the third series of these researches, in which he expresses his belief that the magnetic action of a given quantity of electricity is also definite ; and he is now more confident than ever that this view will be fully confirmed by future experiment.

The reading of a paper, entitled, " An Inquiry into the Nature of Death ; being an attempt to ascertain its more immediate causes, with a view to the better regulation of the means of obviating them." By A. P. W. Philip, M.D., F.R.S. L. & Ed.—was commenced.